

A BIOLUMINESCENT GORGONIAN, *LEPIDISIS OLAPA*,
NEW SPECIES (COELENTERATA: OCTOCORALLIA),
FROM HAWAII

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ABSTRACT

Lepidisis olapa, a new species of gorgonian discovered in deep water off Oahu, Hawaii, is described. Living colonies observed during submarine dives were luminescent when mechanically stimulated. Although common in the order Pennatulacea, luminescence is apparently unusual in the order Gorgonacea, and has never before been observed in colonies in their natural environment. The subfamily which includes *Lepidisis*, the Keratoisidinae, is revised, the three included genera being characterized by their distinct branching patterns.

Only once, in a brief note in de Folin, and Périer (1881) has a bioluminescent gorgonian coral been observed and described. De Folin reported magnificent luminous flashes from specimens [most likely *Isidella elongata* (Esper 1788)] collected from 564 m in the Bay of Biscay, TRAVAILLEUR station 69. Unfortunately, the systematic report on the collection (Marion, 1906) makes no mention of bioluminescence nor of any gorgonians from that station. Luminescence in other members of the Octocorallia (order Pennatulacea) has long been observed (Rondelet, 1954; Agassiz, 1850; Panceri, 1871; Harvey, 1957) and has formed the basis for numerous physiological studies (Parker, 1920; Buck, 1973; Wampler et al., 1973).

In January and February of 1978, I was privileged to make several dives in the STAR II, a 2-man submarine used routinely by a jewelry manufacturer, Maui Divers of Hawaii, to collect precious coral. (The precious pink coral is a gorgonian with a dense calcereous skeleton that can be polished to a high luster.) During these dives, in 400 m 6 mi off Makapuu Point, Oahu, I discovered a gorgonian that luminesced spectacularly when bumped by the submarine collecting basket.

The luminescent gorgonian is a slender, unbranched, spiral colony, generally growing to over 2 m long. Known as the "bamboo"

coral, it has an axial skeleton of alternating white calcareous internodes and dark brown "horny" collagenous nodes. (The *Isidella* observed by de Folin has a similar skeleton, but is branched and bushy.) The internodes are stiff and slightly curved, 3-7 cm long, their diameter at the base of the colony exceeding 1 cm and diminishing to 2 mm or less at the tip (Fig. 1). The nodes are particularly flexible in the distal half, permitting the colony to form a spiral that bends with the current (Fig. 2). The skeleton is covered with the colonial living tissue, the coenenchyme. The coenenchyme and polyps (Fig. 3) consist of epidermal layers enclosing mesoglea and calcareous sclerites (Fig. 4). It is this thin superficial tissue which luminesces.

The luminescence, observable when the lights of the submarine were turned off and a *Lepidisis* colony was mechanically stimulated, consisted of bright flashes of white light which advanced in waves from the point of stimulation. The waves were each about 1 cm broad, 2-3 cm apart, and travelled 2-3 cm/sec up and down the colony, crossing and continuing uninterrupted as two waves met and passed. Just the living tissue, both coenenchyme and polyps, luminesced. Viewed through the portholes, at a distance of less than 1 m, each pulse or band of light appeared to spread evenly over the tissue. Sometimes, with

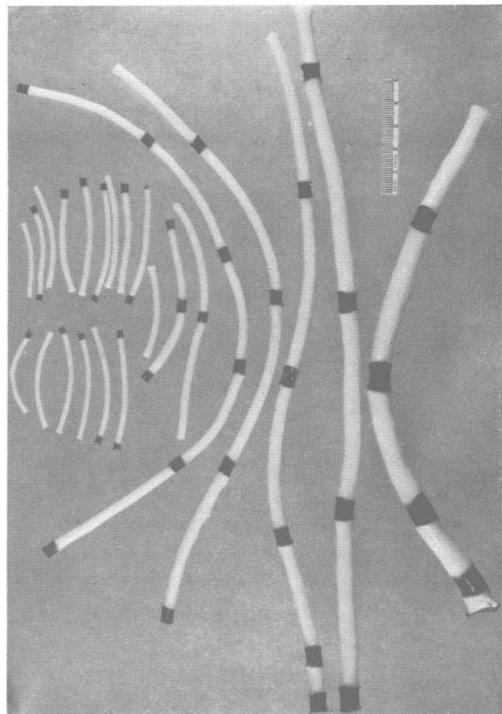


Figure 1. Photograph of a partially intact axial skeleton of a colony of *Lepidisis olapa* new species (USNM 56926), the living tissue removed. Intact, the colony was over 225 cm long, the distal half coiled in a spiral. The base of the colony is on the right, successive internodes to the left. The white internodes are calcareous and stiff, the dark brown nodes collagenous "gorgonin" and flexible. Scale measures 5 cm.

repeated stimulation, an entire colony luminesced everywhere at once. The displays lasted without diminishing appreciably during about 10 min of observation. Colonies in the collecting basket, still at depth, were capable of emitting light at least half an hour after collection.

The depth range of the STAR II submarine limits observations to depths of 450 m or less. *Lepidisis* colonies appear to be common from 400–450 m and extend even deeper. This depth range is typical of other stations where *Lepidisis* has been collected. At this depth, the habitat is nearly dark, comparable to a poorly moonlit night on land, the pale,

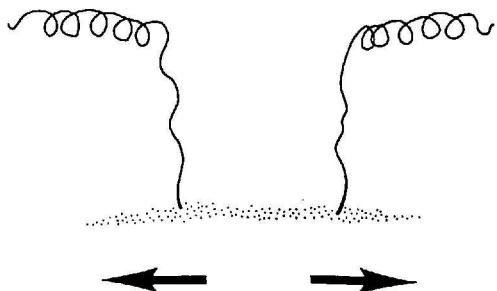


Figure 2. Diagrammatic drawing of live colonies of *Lepidisis olapa* new species bending in current. Arrows show current direction. Current at the Makapuu Point collecting site is bidirectional, reaching 3–4 knots. Colonies grow to over 2 m tall.

coiled colonies just barely discernible. Spotlights from the submarine are necessary to observe and collect. The sea floor at the Makapuu site ($21^{\circ}18'N$, $157^{\circ}32'W$) is a smooth, hard, gently sloping volcanic substrate, covered with a thin (5–10 cm) layer of sediment. *Lepidisis* is abundant in patches, in densities of up to 4 per m^2 , but generally more distantly spaced. Other species of gorgonians, all branched flabellate forms, are present, as well as pennatulaceans, sponges, starfish, large rays, fish, crabs, and other organisms. The octocoral fauna of Hawaii consists of over 100 species, only four of which grow in shallow water. Although no other gorgonians were observed to luminesce (testing included contact with *Isidella* colonies, a branched "bamboo" coral closely related to *Lepidisis*; with *Corallium* colonies, the precious pink coral; and with *Callogorgia*), other coelenterates there do. The polyps of an undescribed species of pennatulacean flash brilliant green; those of a zoanthidean known as the "gold" coral, a *Gerardia* species with an arborescent skeleton, flash blue light.

The cause, under normal circumstances, and the purpose, of the splendid light production by *Lepidisis olapa*, are unknown. Gorgonians are sessile animals, the deep-water forms feeding on suspended matter and small organisms caught by their polyps.

Since the colonies apparently flash only when touched, it is doubtful that the light serves to attract prey items. It is conceivable that the light discourages would-be predators, although most predation reported on gorgonians is by molluscs (Patton, 1972). The nature of the luminescent compounds and the mechanism of the bioluminescence also await investigation.

Lepidisis Verrill, 1883

Lepidisis Verrill, 1883: 18 [part]; (type-species, *Lepidisis caryophyllia* Verrill, 1883, by subsequent designation, Kükenthal, 1915: 119).—Kükenthal, 1915: 119 [part]; 1919: 569 [part]; 1924: 417 [part].—Deichmann, 1936: 240 [part].—Bayer, 1956: F222 [part].

Not *Lepidisis* Grant, 1976: 30 (= *Keratoisis*).

Acanella.—Verrill, 1883: 13 [part].—Wright & Studer, 1889: 29 [part].

Bathygorgia Wright, 1885: 691 (type-species, *Bathygorgia profunda* Wright, 1885, by monotypy).—Wright & Studer, 1889: 32.

Ceratoisis.—Wright & Studer, 1889: 26 [part].—Hickson, 1907: 5 [part].—Kükenthal, 1915: 120 [part]; 1919: 585 [part]; 1924: 423 [part].—Deichmann, 1936: 246 [part].

Keratoisis.—Bayer, 1956: F222 [part].—Tixier-Durivault, 1966: 434 [part].—Grant, 1976: 15 [part].

Diagnosis.—Unbranched Keratoisidinae.

Description.—Colonies long, unbranched. Axial skeleton of alternating calcareous internodes and purely horny nodes. Anchored by a calcareous holdfast, spreading on hard substrate, rootlike in soft substrate. Polyps cylindrical, nonretractile. Sclerites of coenenchyme and polyps elongate rods which may be pointed and needlelike. Short rods with a median constriction, flattened and scalelike in some species, may be present. Sclerites of pharynx flat or stellate rods.

Remarks.—Because of the unreliability of the sclerites as characters to distinguish the genera of the subfamily Keratoisidinae, the division of the group on the basis of branching pattern is here proposed. The type-species of *Lepidisis* is unbranched. The type of *Keratoisis* (*K. Grayii* Wright, 1869, by monotypy) branches at the internodes. The

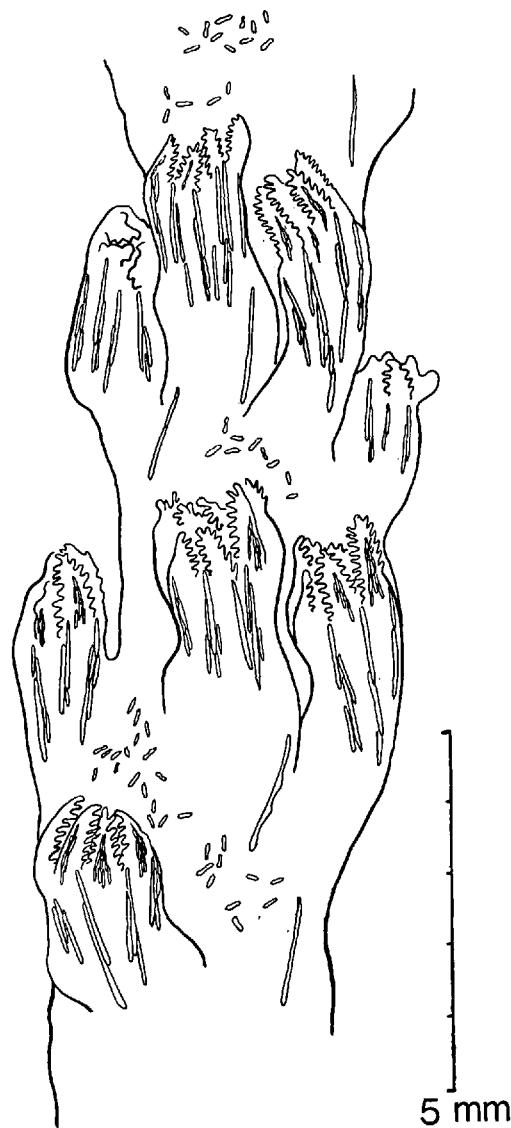
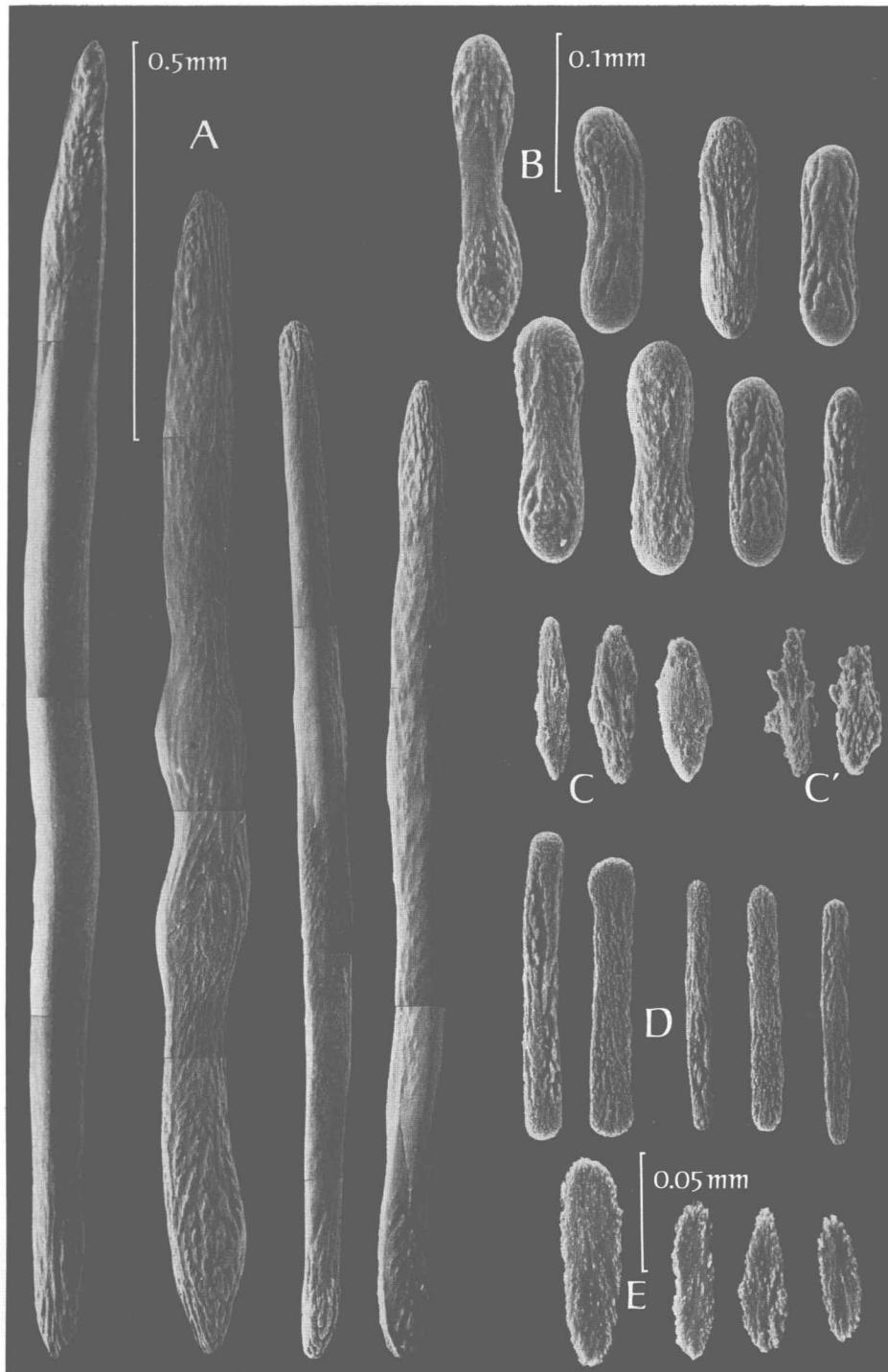


Figure 3. Camera lucida drawing of polyps and coenenchyme from a preserved stem of the type-colony of *Lepidisis olapa* new species to show arrangement of sclerites.

type of *Isidella* (*Isis elongata* Esper, 1788 by monotypy) branches at the nodes. These three genera compose the subfamily. *Acanella* Gray (in Wright, 1869: 26) is a junior synonym of *Isidella*. *Bathygorgia* Wright (1865) is a junior synonym of *Lepidisis*.



Lepidisis olapa new species

Figures 1-4

Diagnosis.—Colonies to 2 m long, basally rather straight and stiff, terminally spiral and flexible. Internodes hollow, 3-7 cm long, 0.15-1 cm diameter, nodes 0.2-1 cm long. Polyps nonretractile, 3-4 mm high, on three sides of stem in diagonal clumps. Sclerites of coenenchyme scattered cylindrical rods, 0.1-0.2 mm, and long needles to 2 mm. Polyp sclerites similar, arranged in intertentacular rows, not projecting above tentacle bases. Tentacle backs with numerous flat blunt rods, 0.1-0.18 mm; pinnules with 2-4 shorter flat rods, 0.05-0.08 mm; pharynx with smooth and flat rods or poorly developed double star sclerites, 0.07-0.11 mm.

Material examined.—HOLOTYPE: USNM 56707, Makapuu, Oahu, 21°18.00'N, 157°32.7'W to 21°18.00'N, 157°32.9'W, 362 m; R/V TOWNSEND CROMWELL, R. Grigg "Sango" Station XIV Haul 1, Jan. 18, 1972, tangle nets. SCHIZOHOLOTYPE: Bernice P. Bishop Museum, D523. PARATYPES: USNM 56795, Makapuu Point, Oahu, 400 m, R/V PELE, V. Brock, 1967; 56705, 56706, 56713, Makapuu Point, Oahu, 21°18.46'N, 157°32.6'W to 21°17.8'N, 157°32.84'W, 215-665 m, R/V TOWNSEND CROMWELL, R. Grigg "Sango" station III Haul 1, Aug. 13, 1970, tangle nets; 56696, Makapuu Point, Oahu, 21°18.9'N, 157°33.45'W to 21°19.8'N, 157°33.45'W, 344-463 m, R/V TOWNSEND CROMWELL, R. Grigg "Sango" station XIV Haul 1, Jan. 18, 1972, tangle nets; 56699, 56710, Makapuu Point, Oahu, 21°18.00'N, 157°32.7'W to 21°18.00'N, 157°32.9'W, 362 m, R/V TOWNSEND CROMWELL, R. Grigg "Sango" station XIV Haul 1, Jan. 18, 1972, tangle nets; 56815, Makapuu Point, Oahu, 21°18'N, 157°32'W, 400 m, STAR II, K. Muzik and B. Bartko submarine dive 1, Jan. 27, 1978; 56838, Makapuu Point, Oahu, 21°18'N, 157°32'W, 450 m, STAR II, K. Muzik and B. Bartko submarine dive 2, Feb. 1, 1978; 56709, Kaena Point, Oahu, 359-421 m, R/V TOWNSEND CROMWELL, R. Grigg, Sept. 30, 1970, tangle nets; 56712, Kaena Point, Oahu, 21°37.9'N, 158°22.95'W to 21°37.4'N, 158°22.3'W, 373-436 m, R/V TOWNSEND CROMWELL, R. Grigg "Sango" station IV

Haul 1, Sept. 30, 1970, tangle nets; 56717, Necker Island, 23°33'N, 164°54'W, 421 m, R/V TOWNSEND CROMWELL station TC 76-06-73, Oct. 21, 1976, fish trawl.

Etymology.—From Hawaiian "olapa," to flash.

Description.—The type-specimen consists of three fragments, the longest one 26 cm long, with seven internodes, the longest internode 3.5 cm long, 2 mm in diameter. Internodes are hollow, the lumen 1 mm or less in diameter, and apparently continuous through the nodes. Nodes are visible through the light beige, thin coenenchyme as dark brown segments of the axial skeleton. Polyps 3-4 mm long, projecting distad, grouped on three sides of the stem in loose diagonal clumps of 3-5 polyps, 8-10 polyps per cm branch.

Sclerites of the coenenchyme are very few long needles, up to 2 mm long (Fig. 4A), usually located near the polyp bases, and more frequent cylindrical rods with a median constriction, 0.1-0.2 mm long (Fig. 4B). These rods are most easily visible in the coenenchyme over nodes.

Sclerites of the polyps are prominent but not projecting smooth needles, 0.3-2 mm long, arranged in intertentacular rows, usually just the abaxial ones, each row 2-3 needles long, 1-3 needles wide (Fig. 3 and Fig. 4A). The longest needles often have irregular median bulges and signs of repaired fracture. Rods with a median constriction, similar to the coenenchymal rods, are occasionally present. Tentacle bases and backs have numerous, longitudinally placed, flat narrow rods with blunt ends, 0.1-0.16 mm (Fig. 4D). Pinnules each have 2-4 similar but shorter flat rods, 0.05-0.08 mm, often with rounded ends and a median constriction (Fig. 4E). Pharyngeal rods, 0.07-0.11 mm,

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Figure 4. SEM photographs of sclerites from the type-colony of *Lepidisis olapa* new species. A, needles from polyps and coenenchyme; B, rods from coenenchyme; C, smooth rods from pharynx. (C', poorly developed stellate rods from the pharynx of a paratype, USNM 56705, to show intra-specific variation); D, flat rods from tentacle bases and backs; E, flat rods from pinnules. Scale at A applies to A; at B to B, C, C' and D; at E to E.

are smooth and flat, with tapered ends (Fig. 4C).

OBSERVATIONS ON LIVING COLONIES: Colonies grow to over 2 m long, with the basal diameter exceeding 1 cm. Spirals are both clockwise and counter-clockwise, the tightness of the spiral being variable. Polyps project nearly perpendicularly, and a narrow tract, free of polyps, spirals up the colony. The coenenchyme and polyps are whitish, the dark nodes and white internodes distinguishable through the living tissue. The colony luminesces when mechanically disturbed (see text).

VARIATION: Variation in internode length is large and apparently random, both within a colony and from colony to colony. Polyps are sometimes all around the stem in very basal parts of colonies. Needles of polyps are sometimes scarce, as few as one or two long ones per polyp and occasionally only short ones. Some tentacle backs have very few rods. Pharyngeal sclerites are poorly developed "stellate rods" in some colonies (Fig. 4C'). Coenenchyme color varies from light yellow or beige to light brown in preserved specimens.

Associated organisms.—Actinians are present on several colonies, and a large cluster of barnacles of the genus *Heteralepas* is present on USNM 56717.

Comparisons.—*Lepidisis olapa* most closely resembles *Lepidisis nuda* (Wright and Studer) from Fiji, but *nuda* has no sclerites in the coenenchyme, and the longest reported from the polyps are only 0.77 mm long. Polyps of *nuda* are longer (5 mm) and all around the stem. *Lepidisis rigida* (Kükenthal) from West Africa, and *L. paucispinosa* (Kükenthal) from Japan, have much larger polyps and longer needles in the coenenchyme and polyps.

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